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JOURNAL OF THE

BOSTON SOCIETY OF CIVIL ENGINEERS

Volume XXXII OCTOBER, 1945 Number 4

PRESSURE TREATED WOOD — A MODERN MATERIAL FOR ENGINEERING STRUCTURES

By Ralph H. Mann*

(Presented at a meeting of the Boston Society of Civil Engineers held on September 26, 1945.)

On August 14, 1945 the forces of the United States, together with the United Nations, brought World War II to a victorious conclusion. Let us devoutly hope that through American leadership there may be no such other global cataclysm either for "our time" or that of our grandchildren.

Compacted into the past six years of struggle for existence as a free people was the equivalent of probably more than 50 years of normal scientific and technological progress. To a large extent, the efforts we now put into effect will enable future historians to determine whether these achievements may be considered as advancements in human civilization. Will jet propulsion and the release of atomic energy, to mention only two of this war's outstanding developments, be considered a blessing or a scourge to humanity?

Vision and inspired leadership are essential to the continued greatness of America. The part played by engineers in the world's present technological advancement is a primary one. Therefore, as engineers are essentially *builders* instead of destroyers of material things, I believe that our profession can and should use its inherent vision, together with its capabilities of leadership so to harness the forces of nature to the benefit of man that a long era of peace and prosperity may come to America and to the world.

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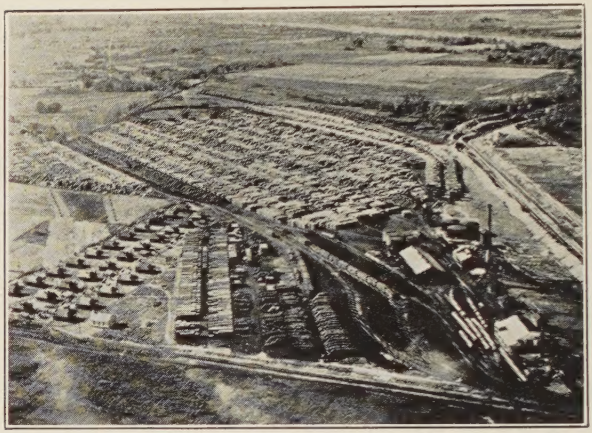

FIG. 1.—BIRD'S-EYE VIEW OF PRESSURE TREATING PLANT AND STORAGE YARD

I believe that we are entering upon a new era of construction in the United States. To engineers, the builders of the post-war world, materials of construction are naturally of fundamental moment. On all sides we hear of new materials of which this brave new world is to be built. Only the future will show us which of these will be found of permanent benefit to our profession as basic materials for engineering construction.

I have been asked to discuss briefly pressure treatment of wood for enduring engineering structures. Of course, wood is not a new material of construction. It is, however, the basic or elemental structural material. It was used by man long before the dawn of recorded history, and has continued in use, until today it is used in great quantities for construction of homes, bridges, buildings, foundations, boats and other transportation devices, as well as for a legion of other things built by the engineer. Its utilization by engineers during the war has probably been more universal than during the preceding 50 years.

During the war years, engineers turned to wood, and found it good. Those years also brought about distinct advancements in the art of timber design and utilization, including metal timber connectors which revolutionized joint design; glued laminated members; arched trusses and prefrabricated structures; to say nothing about the utilization of plywood for boats, airplane parts, etc. Another modern

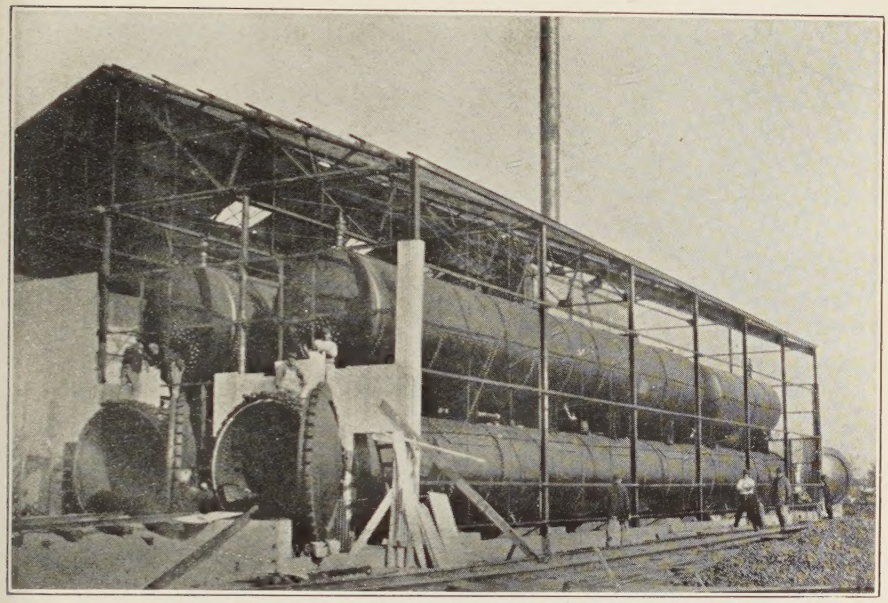

FIG. 2.—EXTERIOR VIEW OF MODERN TREATING PLANT DURING CONSTRUCTION. TREATING CYLINDERS ARE USUALLY FROM 6 TO 9½ FEET IN DIAMETER AND FROM 50 TO 150 FEET IN LENGTH

development consists of the timber-concrete composite beam and slab construction which will be discussed later.

In the discussion of wood as the primary material of construction and its modern development, the subject of wood preservation is a natural corollary. The following remarks will deal solely with the impregnation of piles and timber by modern standard pressure processes of impregnation.

The pressure treatment of forest products is, of course, not a development of the past war. It began in England in 1838. Its greatest development and widespread use, however, have been in the United States. It should be of interest to you locally, to know that the first recorded attempt made in America to treat wood under pressure was in 1865, when a treating plant was built at Somerset, Mass., by the Old Dighton & Somerset Railroad to treat bridge piles. This plant consisted of one cylinder 64 ft. long, a tank for the preservative, a steam boiler and a pump. It operated on a 12-hour day and turned out 12 piles daily.

The 1944 statistics of the Forest Service, U. S. Department of

Agriculture, disclose that there were 169 pressure-treating plants then operating in the United States, and that the equivalent of 3,332,240,724 ft. B.M. of wood was treated with preservatives that year. The average gross quantity of wood so treated over the past 10 years in the United States closely approximates 10 per cent of the total amount of lumber consumed. I cite this item in confirmation of our assertion that the preservative treatment of forest products in the United States is of major importance in our national economy. Wood preservation is, in fact, national conservation of natural resources.

Railroads Pioneer Preservative Treatment

Railroads are and have been the greatest users of timber, requiring annually great quantities for crossties and piling for bridges and other miscellaneous structures. No other tie can compare with the wood crosstie. The American Railway Engineering Association's Committee 3—Ties, reported that for 1944 the tie installations in this country amounted to 44,907,119 treated and 2,935,837 untreated ties. The treated ties therefore comprised nearly 94 per cent of the total. For the country as a whole the average cost of an untreated tie was $1.28 and that of a treated tie $1.98, but the difference in service life is so great that the treated tie is a decided economy, despite its higher first cost. The average life of untreated ties of all species is approximately six years, as shown by carefully maintained records that include all sections of the United States. The average life of pressure-creosoted ties is today well over 25 years in track and the bulk of renewals are made because of mechanical wear and not because of decay. With improved road-beds and track common on important roads today, mechanical wear is being reduced and an average tie life of thirty years or more can be expected. Thus, through preservative treatment one tree is doing the work that would require four or five if the timber had been installed untreated. This is evident economy and it has been estimated reliably that American railroads thereby save $145,000 every day. Moreover, it is essential conservation of forest products.

The magnificent transportation job done by the railroads throughout the war period was in a large part due to the excellent condition of their track systems made possible by the long service life of treated

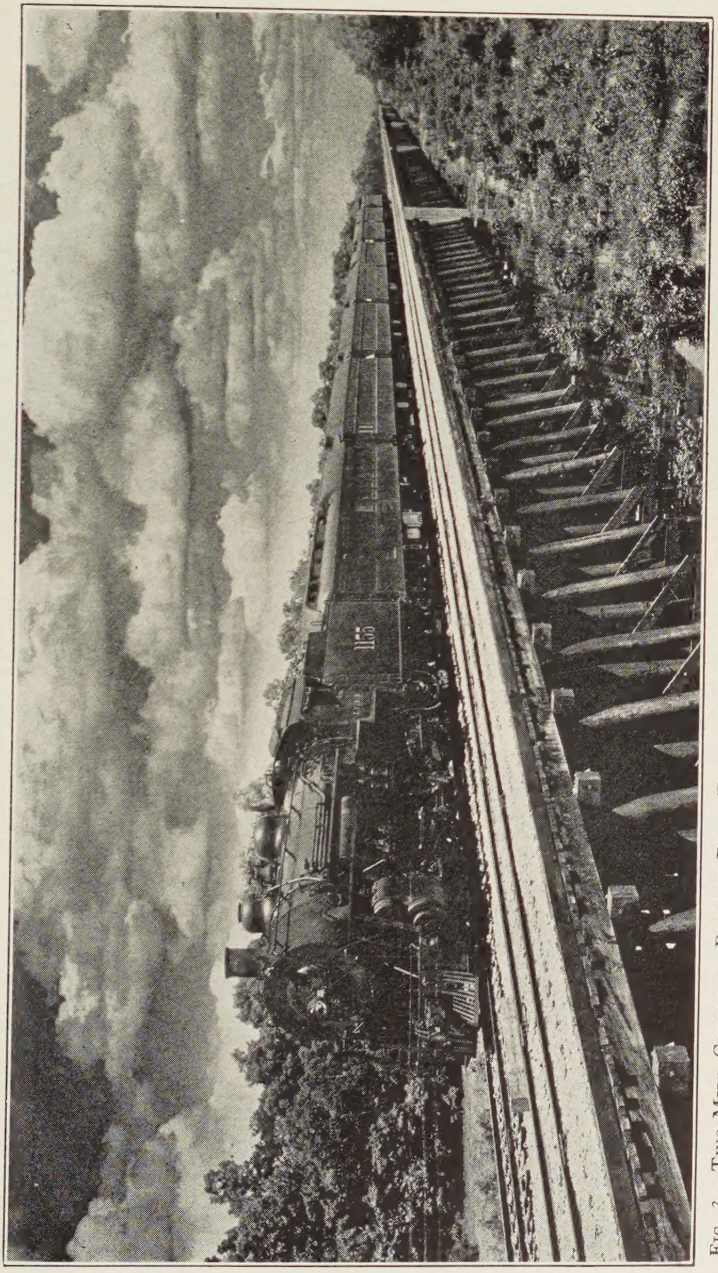

FIG. 3.—TWO-MILE CREOSOTED BALLAST DECK TRESTLE ON ILLINOIS CENTRAL RAILROAD NEAR BONNET CARRE SPILLWAY, LOUISIANA. CONTAINS OVER 10,000 CREOSOTED PILES AND 4,500,000 BOARD FEET OF CREOSOTED TIMBER

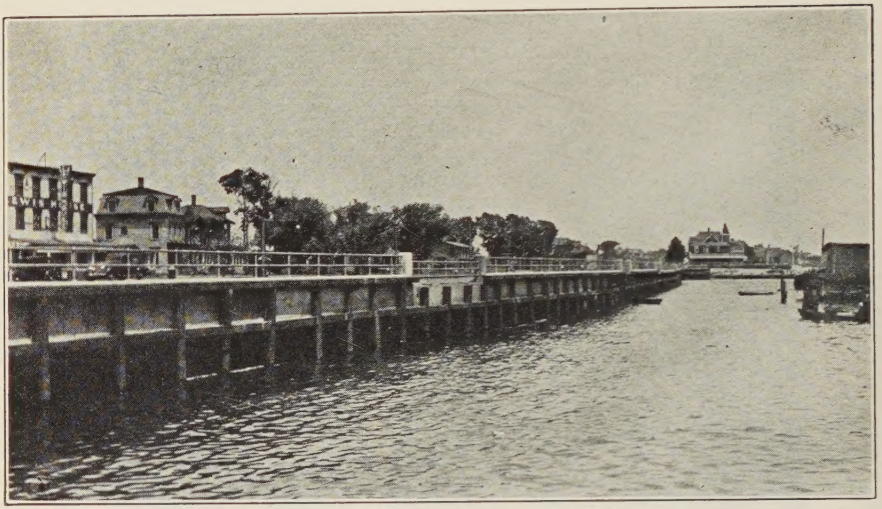

FIG. 4.—CREOSOTED SHEET PILE BULKHEAD COPED WITH CONCRETE ON SHEEPSHEAD BAY, BROOKLYN, N. Y. SHEET PILES 8″ x 12″ x 28′, GROOVED FOR SPLINES

crossties during the period of record-breaking traffic, when maintenance forces were subnormal and materials for repairs unavailable. The American railroads can, indeed, be said to be the proving grounds for treated timber.

Public utilities, the second largest consumer of treated wood, have also proven to their satisfaction the economic benefits derived from preservative treatment of wood poles and cross arms, and pressure creosoted poles 40 or more years old are still in good condition. In the year of peak production, before we suffered a severe depression from which we had not recovered before the onset of war, over five million poles were treated.

State highway departments have used quantities of treated timber for the last two and a half decades, and excellent service records are being built up in that field. Structures now in constant use for 25 years and more promise many additional years of service.

Port authorities have come to depend on large volumes of treated timber for their construction programs. There are many instances here on our east coast where structures of this material have withstood decay and marine borer attack in a remarkable manner. On our west coast, where marine borers are very active, creosoted piles removed from obsolescent structures after 38 years'

FIG. 5.—CONSTRUCTION VIEW OF TWO-MILE LONG CREOSOTED SHEET PILE BULKHEAD—RETAINING WALL ON ATLANTIC OCEAN, SOUTH OF LONG BRANCH, N. J. SHEET PILES ARE 8″ X 12″ X 28′, COPING AT PLUS 16.0 ABOVE MEAN LOW WATER. BUILT 1941.

service were still in good condition and installed in new structures in the same general location.

These uses are mentioned particularly here because they are some of the better known uses, but there are scores of other fields for the product, which require hundreds of thousands of feet of treated timber every year. Among these are irrigation structures, river bank protection, foundation piles, farm structures and vulnerable members of residential and other buildings, interior flooring, posts and guard rails, pipe lines, etc.

But one thing must be kept ever in mind. Not all so-called treated timber will give the results the purchaser desires. To do so, it must be properly pressure treated in accordance with standard specifications of the industry, it must be adequately penetrated with the stipulated amount of the proper preservative for the particular purpose for which it is to be used, and the wood itself must be a suitable grade of a treatable species and sound at the time of treatment. If these conditions are followed the resultant product is a distinct material of construction, one not to be confused in any way with untreated wood.

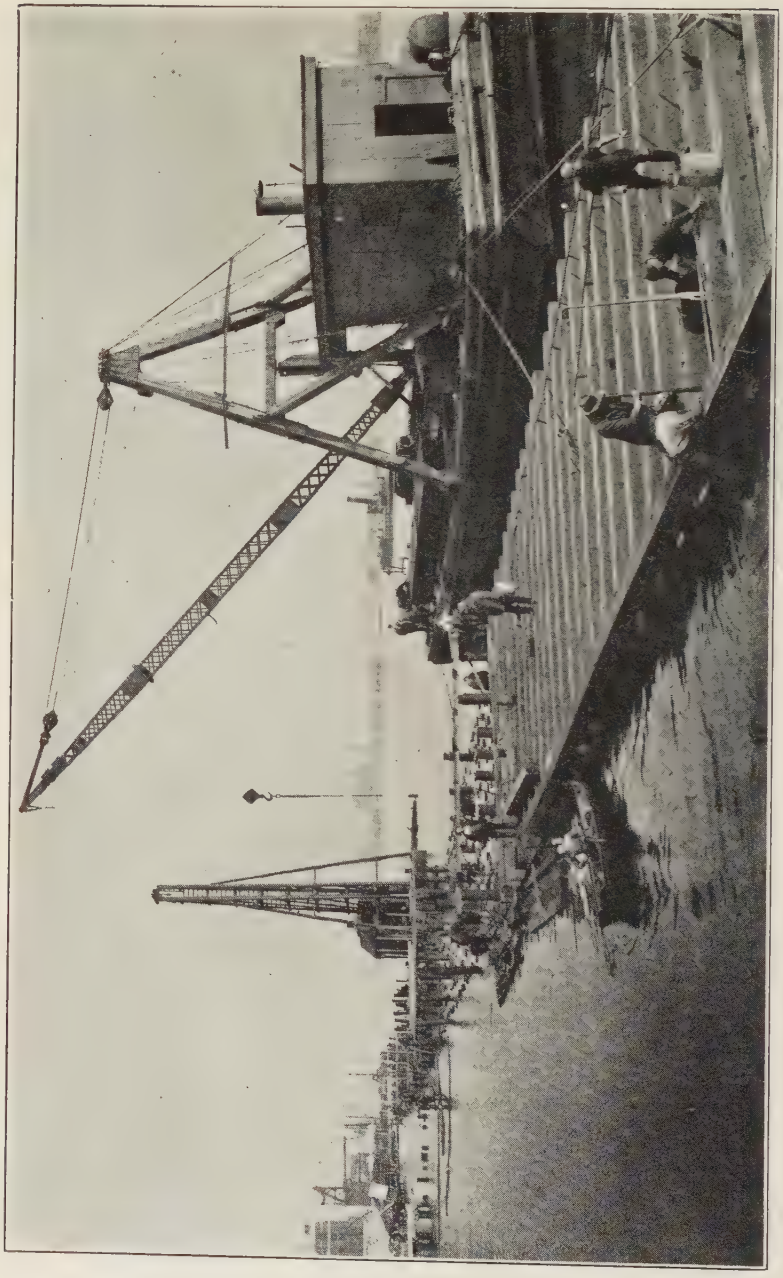

FIG. 6.—RELIEVING PLATFORM BULKHEAD OF CREOSOTED PILES AND TIMBERS, IN NEW YORK'S EAST RIVER DRIVE LOOKING NORTH FROM EAST 5TH STREET, EAST RIVER

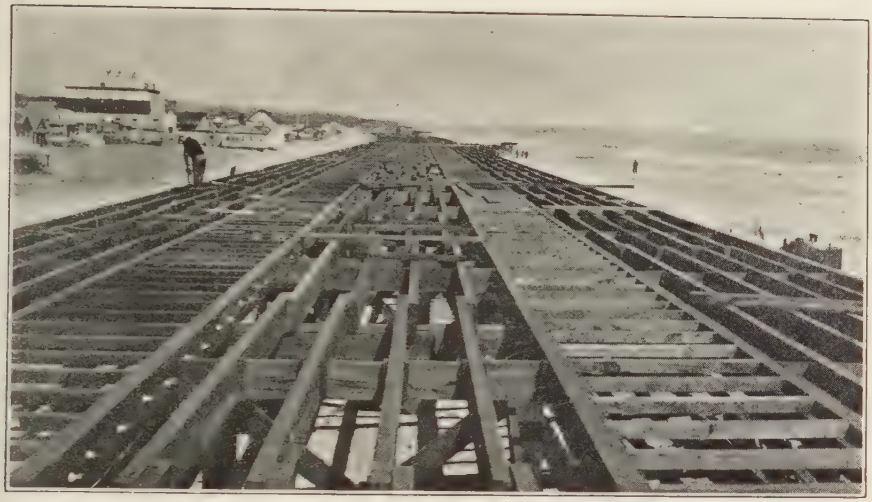

FIG. 7.—CREOSOTED PILE AND TIMBER SUBSTRUCTURE OF BOARDWALK, STATEN ISLAND, NEW YORK

WHAT CONSTITUTES GOOD TREATMENT

It is seldom practicable, and it is entirely unnecessary, for the purchaser to make a study of the details of preservative treatment. If he were to make a study of the wood structure, however, the manner in which untreated wood is destroyed by its common enemies, decay, insects, and marine borers, and the manner in which preservatives forestall such destruction, he would realize more fully the importance of treating specification. The specifications of the American Wood Preserver's Association for preservatives and for treatment have been formulated by the combined activities of timber producers, manufacturers of preservatives, treating plant officials, and the consumers themselves, with the one objective of giving the purchaser a product that will be satisfactory in every respect. You may not be interested in a discussion of these specifications, but when any of you have occasion to specify treated wood I should like to urge that you follow these specifications throughout. Federal Treating Specification TT-W-571b follows these standards.

The primary American species from which structural lumber is obtained are southern yellow pine and Douglas fir. These species combine strength and treatability and comprise the greatest available stands of structural timber in the United States today. They also have equivalent stress rating, grade for grade.

Sapwood on timber to be treated should not be restricted, for it is readily penetrated by the preservative and when properly treated is more durable than the most resistant heartwood in its natural state. Moreover, the sapwood is equally as strong as heartwood. Timber with little or no sapwood, such as sawn Douglas fir, is incised or perforated to depths of ½ to ¾ inch before treatment to insure an even depth of penetration and a uniform distribution of the preservative through the treated area.

Too much emphasis cannot be placed on the importance of good penetration of the preservative. A mere coating of the wood is not sufficient, since the slightest crack may permit entrance of some destructive organism. To get the preservative deeply into the wood the pressure process must be employed. To accomplish this, as many of you undoubtedly know, charges of timber loaded on tram cars are run into cylinders 6 to 9 ft. in diameter and capable of withstanding high pressures; the doors are bolted tight; and the pressures, vacuums and temperatures are rigidly controlled throughout the treating cycle to secure the all-important even distribution of the stipulated retention of preservative.

The preservative must, of course, first of all, be toxic to the

Fig. 8.—Connecticut State Pier, New London, Conn. In 1936 a New Deck Was Placed on the 2,000 Creosoted Piles Which Were in Perfect Condition After 22 Years' Service

organisms which destroy wood, but aside from this and other technical requirements covered in the specifications, it must be available in sufficient quantity at reasonable cost; it must be capable of being injected into the wood for appreciable depths; and it must be permanent, that is, it must not evaporate readily. The importance of permanence is evident when it is realized that many of our treated timber structures are required to remain in serviceable condition for periods of 40 or 50 years or more. Chemicals which evaporate from wood in a few years or change in composition cannot be expected to preserve wood for any such length of time. Some of the properties required in a preservative can be measured in the laboratory or by accelerated tests, but their real effectiveness in keeping wood sound can be verified only by long service in actual structures. Unfortunately, no short-cuts have ever been devised for ascertaining with certainty the merits of a wood preservative.

The preservatives recommended by the American Wood Preserver's Association, and most commonly used, are the standard salts—zinc chloride, chromated zinc chloride, and Wolman salts—and coal-tar creosote.

The salts find their greatest application in treatment of lumber for buildings and other uses where it is not in contact with water or with the ground, for that which is to be painted, and for any location where the color or odor of the creosote might be objectionable.

Coal-tar creosote has more general application, as it can be used in the severest conditions, either on land or in water. Recognition of the value of this preservative is given by the American Society of Civil Engineers in its Manual of Engineering Practice No. 17, as follows:

> "It usually results in the lowest annual cost for the structure if treatment and preservative are the best. A great advantage of this type of protection is that it also protects from decay, termites, and wharf borers, as well as marine borers. The best and most reliable preservative so far known is coal tar creosote, used in sufficient quantity and carefully applied."

Each year creosote or creosote mixtures are used for about 97 per cent of the wood treated.

Creosoted piles and timber have been used extensively for marine

structures in the North Atlantic area for the last fifty years. Because of the tremendous construction programs in prospect for the post-war period, demands for all construction materials will in all likelihood far exceed those of past years. Timber properly protected by thorough creosote treatment is particularly adapted to a variety of marine structures such as piers, wharves, docks, sheet pile bulkheads, relieving platforms, marine and terminal structures, railway and highway trestles, barges, ferry racks, and dolphin clusters, among others. Superior strength and lightness, resilience to shock imposed by vessels, and its general utility are characteristic of timber. Carefully selected species and grades of piles and timbers adequately treated, fabricated and installed in good designs can be depended upon for a long service life with low maintenance costs. A review of service records established by creosoted piles in this general area disclosed service lives extending from 30 to over 50 years. Under the constant accumulating knowledge of timber preservatives, impregnation processes, better prefabrication and installation technique, equal or better records will certainly be established by timber in future structures. A noted engineering authority, the Sea Action Committee of the Institution of Civil Engineers of Great Britain, states: "Within the range of the

Fig. 9.—"Steeplechase" Pier—Coney Island, N. Y. Built Upon Creosoted Pine Piles 1904. Age to Date, 41 Years. Piles Remain in Excellent State of Preservation

FIG. 10. ABOUT 7,500 CREOSOTED PINE PILES WERE DRIVEN FOR THE FOUNDATIONS OF THE LARGEST GRAIN ELEVATOR IN THE WORLD AT ALBANY, N. Y. CUT-OFF ELEVATION 10′ ABOVE WATER TABLE

experiments, no process for the preservation of timbers was found more satisfactory than that of impregnation with creosote."

During the last two decades creosoted timber piles have been driven for the foundations of many permanent buildings, bridges and other structures. Piles thus installed, when driven below the ground line and capped with concrete footings, cannot deteriorate if properly treated. The practice of using creosoted piles in permanent foundations was begun many years ago by railroad engineers. More than fifty years ago the Southern Pacific began their use, and today many of their most important buildings, including the modern passenger station at Sacramento, California, are founded on these piles. From the railroads the practice spread to the building industry generally, and many commercial and Government buildings are now supported on this type of foundation.

Inspection of foundation piles completely embedded in the earth is, of course, a rare occurrence, unless there is some cause for apprehension as to their condition. An excellent opportunity of this kind was afforded in 1936, with the proposed revamping of the deck structure on a long intercity viaduct at Kansas City, Missouri. The proposed replacement of the superstructure involved an expenditure of one million dollars, and the existing footings were to be retained only if they could be depended upon for a long period of future service. Of 326 footing pedestals founded on piles, 276 were on creosoted piles all cut off and capped well above the water table. A close and detailed examination of these piles disclosed no sign of deterioration, and all the existing footings were re-used in the new improvement. They had been treated with 12 lbs. of Grade One creosote per cubic foot, and had been in place for 31 years.

Recent Adaptations

Two developments of importance in the use of treated wood in recent years might well be noted here. One was in the field of composite construction, in which cement concrete has been combined with treated structural timber to produce unitary action as a beam or slab. The other was in the extensive commercial use of wood treated for fire resistance. Both developments have opened up new and important outlets for treated timber, and I should like to discuss them briefly.

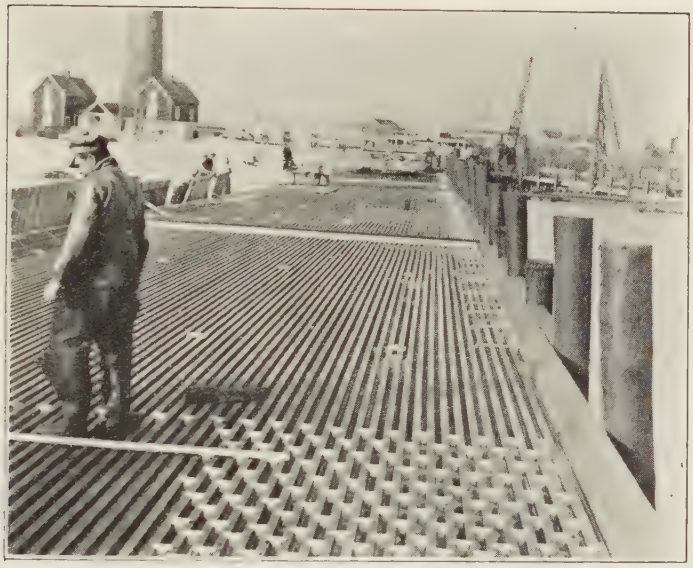

FIG. 11.—COMPOSITE CREOSOTED TIMBER-CONCRETE DECK, U. S. COAST GUARD, SHINNECOCK (LONG ISLAND, N. Y.) STATION, SHOWING CREOSOTED SUB-DECK AND A FEW SHEAR DEVELOPERS IN PLACE BEFORE CONCRETING—1941

The integrity of the composite construction depends upon an effective shear connection between the two materials, and various devices have been employed for that purpose.

The timber-concrete slab which has probably been most widely used consists of a solid laminated timber base with a concrete surface superimposed upon it. The two elements are interlocked at the contact plane by an artificial shear device which converts the assembly into a unit with an effective depth equivalent to the overall thickness of the two materials. The concrete mat, in addition to forming an excellent wearing surface that protects the timber from mechanical wear, distributes concentrated loads over wide areas, and by virtue of the shear connection becomes an effective part of the supporting medium. The timber is strong, both in tension and compression, and has the further advantage of light weight. Combining the two materials in composite construction utilizes each to advantage and results in a product suitable to many modern structures. The composite deck has been tested by actual service under a variety of climatic and load conditions during the last dozen years. It has

FIG. 12.—COMPLETED 1,100-FOOT COMPOSITE CREOSOTED TIMBER-CONCRETE HIGHWAY BRIDGE NEAR JACKSONVILLE, FLORIDA. CREOSOTED PILES AND SUBSTRUCTURE WITH CONCRETE SURFACE. BUILT 1936

been used on highway bridges, on docks, and in buildings where provision must be made for considerable loads or excessive concentrations.

For example, a slab of this type when tested at the National Bureau of Standards failed only when the concentrated test load reached 181,000 pounds. The over-all thickness of the slab was 10 inches. The test specimen consisted of a two-span slab, each 8 feet long, to simulate heavy pier deck construction. It was a critical test for horizontal shear as well as for flexure. The behavior of composite slabs in service for many years, as well as such tests as those of the Bureau of Standards, show that the concrete is relatively flexible and functions with the wood in a very favorable manner. Since the bottom of the concrete occurs at the neutral axis of the beam or slab, the tendency for it to crack is obviated.

In this type of deck construction no forms are required, since the laminated timbers are designed to carry the dead load of the concrete. Such construction also permits of the architectural treatment befitting the situation or requirement. This item applies particularly to highway bridges. The lumber in this construction is seldom highly stressed, and therefore the common grades, which are adaptable to preservative treatment, are entirely satisfactory for the purpose. Properly treated, these grades are extremely durable and in well-designed structures can be depended upon for long service under the most severe conditions of exposure.

Although wood pressure treated for fire retardance has been commercially available for over 30 years in the United States, World War II brought it to extensive usage as an important new structural material. Approximately 100 million board feet of structural timber was treated and installed during the last three years.

Fire-retardant wood is chemically impregnated wood incapable of supporting combustion. When exposed to fire, a slow disintegration of the wood results. The wood checks and chars without bursting into flame or permitting the spread of fire. These treatments retard normal increase of temperature under fire conditions, decrease the rate of ignition and flame spread, reduce ignition hazards, and permit fire-fighters to control a threatening fire and rapidly extinguish it.

A variety of chemicals and combinations of chemicals of proven effectiveness are used commercially for fire retardant treatment.

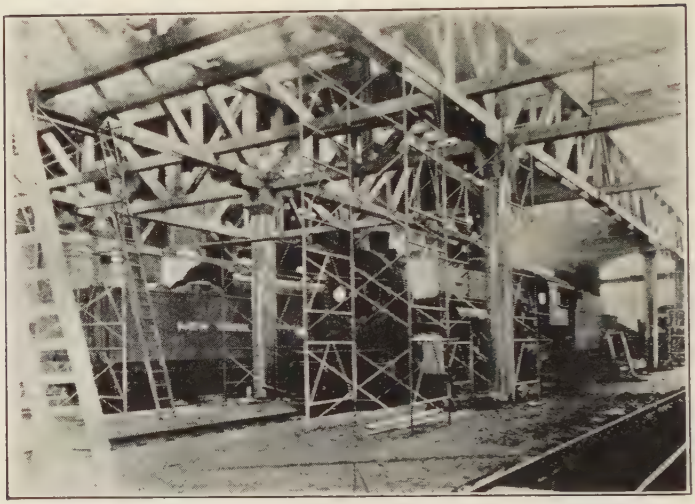

FIG. 13.—FIRE RETARDANT TREATED WOOD TRUSSES AND LUMBER MEETING ASTM TEST C-160-41T WERE USED IN THE ROOF OF THIS NEW YORK CENTRAL SYSTEM ENGINE HOUSE

Briefly, they comprise ammonium-phosphate and ammonium-sulphate in large part, together with such materials as borax, sodium dichromate and boric acid in varying formulations. In certain treating solutions zinc chloride is used primarily to impart decay resistance in addition to fire retardance. Chromated zinc chloride, a wood preservative, is said to possess good fire-retarding qualities when the timber is impregnated with higher than the normal 0.75 pound retention standard for preservation alone.

Standard full-cell processes are used for the treatments. Dry salt absorptions in pounds per cubic foot of wood vary in accordance with species, cross sectional area of the pieces, formulation of the chemicals, and the condition of fire exposure to which the assembly is exposed. In the light of present information, it may be said that effective fire retardance may be imparted to structural members with absorptions ranging from 2½ to 5 pounds of chemical per cubic foot. Several laboratory check tests for fire resistance are in commercial use.

Fire retardant treatment of timber combined with decay and insect attack prevention features brings to the modern engineer a new and important material for use in post-war buildings.

In concluding, I should like to say that although it has been

impossible to tell the complete story of the design, fabrication and treatment of timber, I hope that what I have said and what the slides have shown may have brought to America's oldest Society of Civil Engineers a few interesting thoughts on the proper treatment and economic utilization of the world's oldest structural material.

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Of General Interest

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETING

Boston Society of Civil Engineers

September 26, 1945.—A regular meeting of the Boston Society of Civil Engineers was held this evening at the Twentieth Century Association. Seventy-five members and guests attended the meeting and sixty-three the dinner.

The President announced the death of the following members:

Waldo E. Buck, who was elected a member May 15, 1889, and who died April, 1945.

Louis F. Cutter, who was elected a member April 18, 1888, and who died June 26, 1945.

Carl H. Seils, who was elected a member September 23, 1942, and who died August 2, 1945.

The Secretary announced the election o fthe following to membership on this date:

Grade of Member: C. Lawrence Bond, Sanford S. Mitchell, John J. Stanton.

Grade of Junior: Henry J. Bishop,* Joseph J. Bulba,* Robert N. Kuehn,* George W. Laakso,* Robert J. Markell,* Edward W. Murphy,' Samuel J. Pattison, Jr.*

The President announced that the October meeting will be held at the 20th Century Association, 3 Joy Street, Boston, and will be a Joint Meeting with the Designers Section, BSCE. The speaker will be Captain W. Mack Angas, CEC, U. S. N.

President Farwell introduced the speaker of the evening, Mr. Ralph H. Mann, Field Engineer Service Bureau, American Wood Preserver's Association, who gave an extremely interesting talk on "Pressure Treated Wood—A Modern Material for Engineering Structures." The talk was illustrated with slides. An interesting discussion period followed the talk.

A rising vote of thanks was given the speaker.

Adjourned at 9:00 P.M.

Everett N. Hutchins, *Secretary*

*Transfer from Grade of Student.

APPLICATIONS FOR MEMBERSHIP

[October 20, 1945]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to

applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of fifteen (15) days from the date given.

For Admission

A. Herbert Bruce, Milton, Mass. (b. March 15, 1903, Watertown, Mass.) Graduated from Watertown High School in 1921. Matriculated at Northeastern University 1922 through 1924, course in Civil Engineering. Experience, rodman for Rowland H. Barnes and Henry F. Beal, Civil Engineers, Waltham, Mass., as a cooperative student while at Northeastern University. From 1922 to 1931 with Barnes and Beal. During last six years of this period was engineer in charge of land surveys—topo—development—building construction. From 1933 to 1944, worked as an assistant engineer for the town of Belmont. Work consisted of design of street layouts, drains, sewers, parks, playground, etc., also worked in field layout on above work. From April, 1944 to present, employed by Engineering Department, Town of Milton as assistant engineer on all types of municipal engineering work including street work, drains, land surveys and topographical surveys together with design and computations. Refers to *J. H. Bowie, A. E. Everett, F. J. Maynard, E. L. Moulton.*

Vincent R. Caputo, Medford, Mass. (b. December 4, 1906, East Boston, Mass.) Massachusetts Institute of Technology, Class of 1928, B.S. in Architectural Engineering; Massachusetts University Extension Courses, 1930, Business Law and Business English; ABC license, construction of first, second and third class buildings in Boston. Experience, October, 1931 - December, 1932, Capobianco Construction Company, construction superintendent and estimator, — supervised planning and progress of projects with assistants and sub-contractors; February, 1942 - September, 1942, E. J. Rappoli, at first production engineer, later construction superintendent, supervised planning, purchases, and progress of project, Naval project, building, airports, site development, utilities; September, 1942 - December, 1943, Carrille Construction and John Basile, Associates, construction superintendent, war housing project; December, 1943 - September, 1945, Builders Iron Works, Somerville, Mass., Plant Superintendent. Other employment, U. S. Resettlement Administration, Washington, D. C.; Boston Housing Authority; Army Athletic Association, West Point, N. Y.; U. S. Coast and Geodetic Survey, Washington, D. C.; Public Works Administration, Boston. At present Consultant and Estimator, Builders Iron Works, Somerville, Mass. Refers to *E. S. Averell, C. A. Farwell, C. J. Ginder, E. N. Hutchins.*

Albert S. Hall, Belmont, Mass. (b. July 23, 1895, Cambridge, Mass.) Graduate from Rindge Technical School in 1912, continued education for practically two years at Massachusetts Institute of Technology in class of 1917. Experience, 1912-1915, during vacations and after classes in the Way Department and Engineering Division of the Boston Elevated Railway, Power Station Operator, Timekeeper, Division Clerk and Chief Clerk until 1929. In 1929 promoted to Assistant to the Superintendent of Maintenance, in the supervision of all work of the Department embracing the maintenance and construction of trolley tracks and third rail rapid transit tracks, including the signal system, elevated structures and

bridges, subway equipment, shop and bus garages, including the preparation of plans, specifications and estimates. Since January, 1945, have been acting as the head of the Department during the absence of the Superintendent of Maintenance. Refers to *A. J. Blackburn, Charles E. Davis, E. L. Lockman, L. E. Moore.*

Clifford S. Mansfield, Stoneham, Mass. (b. April 12, 1914, Lynnfield, Mass.) Graduated from University of Maine in 1935, B.S. in Civil Engineering, major—hydraulics. Experience, five years for the Metropolitan District Water Supply Commission, in the field on the construction of the Quabbin Reservoir, serving in the field on the construction of the Quabbin Reservoir, as transitman, Chief of party, inspector, and office engineer; six months with Hartford Ordnance District as an inspector of army ordnance material; three and one-half years with the United Engineers & Constructors of Philadelphia on heavy construction on Steam electric power house as office field engineer, magnesium plant construction as field engineer, car-dumper foundation as job engineer, steel plant rolling-mill as chief of party. At present with Fay, Spofford & Thorndike as Junior Engineer. Refers to *A. W. Caird, F. M. Cahaly, C. A. Farwell, R. W. Horne, K. R. Garland, J. C. M. Tillinghast.*

John J. Scanlon, Melrose, Mass. (b. September 28, 1905, Stoneham, Mass.) Graduated from Stoneham High School 1924; Lowell Institute of M.I.T., 1928. Advanced courses of study at Lowell (M.I.T.) in Concrete Design, 1930; Geo. Washington Univ. Rigid Frames, 1941; Tufts College, Rigid Frames, 1943; Harvard Univ., Journalism, 1944. Experience, Stone & Webster, 1927; Boston & Maine Bridge Dept., 1928; Coolidge, Shepley, Bulfinch & Abbott, 1929; E. T. P. Graham, 1932, Mass. State Highways, 1933; Public Buildings Administration, Washington, 1934-1940; Corps of Engineers. Washington 1940-1942; Jackson & Moreland, Boston and Pittsburg, 1942-1944; Corps of Engineers, Boston, 1944-1945; 1945 to Present, Managing Editor of New England Construction Magazine. Summary, from 1927-1945, structural designer of reinforced concrete, steel and timber structures. Writer for technical and nontechnical publications. Refers to *F. J. Crandall, E. F. Childs, H. S. Swartz.*

Transfer from Grade of Junior

Daniel W. Miles. Chicago, Illinois. (b. July 21, 1917, Norwood, Mass.) Graduated from Northeastern University, class of 1940. Experience, with Town of Norwood, Massachusetts Engineering Department, 1934-1937, from rodman to chief of party; with Liberty Mutual Insurance Company since November, 1937, as Construction Safety Engineer on various jobs such as, 11 Railroad Bridges, Louisville, Kentucky; 2 Federal Housing Jobs, Louisville, Kentucky; 5 Fort Knox Cantonment Projects, Kentucky; 3 Fort Sill Cantonment Projects, Oklahoma; 1 Rolled Earth Dam, $50,000,000 Denison, Texas; 10 Pacific Naval Air Stations from Pearl Harbor to Philippine Islands. Imprisoned by Japanese Army in Philippines from January, 1942 through February, 1945. Refers to *C. O. Baird, E. A. Gramstorff, E. N. Hutchins, E. L. Spencer.*

Edward F. Wilcox, Torrington, Conn. (b. September 3, 1909, Torrington, Conn.) Graduated from Northeastern University in 1932, with degree in Civil Engineering. Experience, August, 1932-March, 1933, Assistant Engineer with V. & M. Construction Corporation in Brockton, Mass., Post Office; Septem-

ber, 1933-June, 1934, Engineer and Patrolman with Conn. Forestry Department; July, 1934-March, 1941, Junior Engineer with C.C.C. in Conn., layout and construction of roads, bridges and dam; March, 1941-March, 1942, Junior Resident Engineer wth N. H. Highway Department, inspection and highway design; March, 1942-August, 1942, Junior Engineer with Doyle, Russell & Wise, Contracting Company of Richmond, Virginia, building, layout and checking construction on Army Warehouse; August, 1942-April, 1944, Assistant Engineer with Fraser-Brace Engineering, Inc., of New York, Assistant Area Engineer of Manufactuing Area for R.D.X. Explosives Plant, 22 construction engineers in field under my supervision; April, 1944-June, 1944, Supervisor with Tenn. Eastman Corp., at Oak Ridge, Tenn.; June, 1944-October, 1945, Area Engineer with Mason & Hanger Corporation, Area Engineer over 156 buildings for Rocket Powder Plant at Baraboo, Wisconsin. Refers to *C. O. Baird, C. Ell, A. E. Everett, E. A. Gramstorff, J. B. Komich.*

Abraham Woolf, Mattapan, Mass. (b. July 18, 1907, Boston, Mass.) Graduated from Massachusetts Institute of Technology, 1928, S.B. in Architectural Engineering. Experience, 1928-1931, Stone & Webster 1932-1936, Mark Linenthal; 1935, Commonwealth of Massachusetts; 1936, A. G. McKee, Cleveland, Ohio; 1937-1945, Albert Kahn, Inc., structural and civil engineer, designer and draftsman. Refers *to A. Casagrande, A. G. H. Dietz, H. A. Mohr, D. W. Taylor, J. B. Wilbur.*

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Juniors

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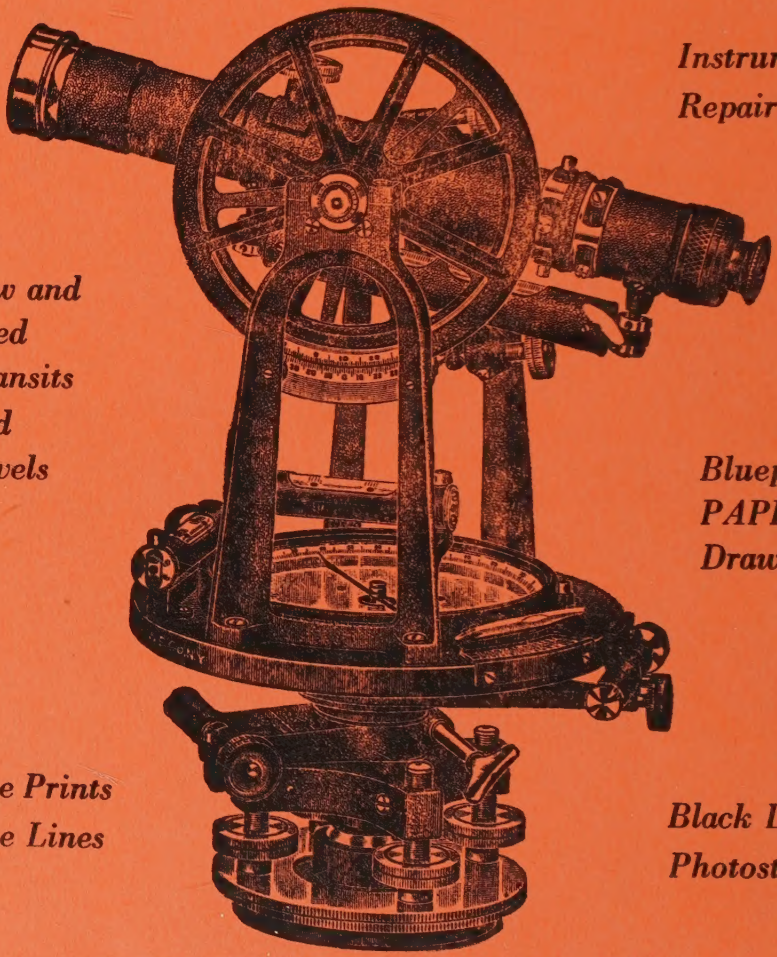

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